THE CRAB FAUNA OF WEST ISLAND, SOUTH AUSTRALIA: THEIR ABUNDANCE, DIET AND ROLE AS PREDATORS OF ABALONE

By A. G. J. Mower & S. A. Shepherd*

Summary

Mower, A. G. J. & Shepherd, S. A. (1988) The crab fauna of West Island, South Australia: their abundance, diet and role as predators of abalone. *Trans. R. Soc. S. Aust.* **112**(2), 83–86, 31 May 1988.

Twenty-three species of crabs are recorded from West Island, South Australia. The vertical distribution and densities of sixteen species occurring on the boulder slope at Abalone Cove on the northern side of the Island, are described and the diets of the five most common species enumerated. Four of the species are mainly herbivorous but eat small amounts of animal matter and one species is omnivorous. Four of the species also ate small abalone in cage experiments and represent potential agents of abalone mortality.

Key Words: crabs, abalone, diet, predation.

Introduction

The need to understand the recruitment process in abalone, necessary for the proper management of abalone fisheries has focused increasing attention on the ecology of juveniles and in particular of the agents of mortality. Dead abalone shells are frequently found damaged in different ways, but there is dispute whether this is caused by crabs, or is due to natural causes such as abrasion (Hines & Pearse 1982; Tegner & Butler 1985).

Studies on the ecology of juvenile *Haliotis laevigata* Donovan, and *Haliotis scalaris* Leach have been in progress at West Island, South Australia (35°36′25″S; 138°35′27″E) since 1983 (Shepherd & Turner 1985) but their predators are still largely unknown. Several crab families, which are represented at West Island, are known to attack and feed on molluscs, often inflicting shell damage (Skilleter & Anderson 1986; Vermeij 1977; Zisper & Vermeij 1978; Williams 1982).

This study describes the abundance and diet of the crab species present on a boulder slope at West Island the site of earlier studies, and gives the results of preliminary experiments to determine whether crabs eat abalone and the type of damage to the shell inflicted by them. An ancillary purpose was to accumulate information on a group of consumers, leading to a better understanding of the benthic food-web of the Island.

Materials and Methods

Twenty samples were taken at 1 m depth intervals from 1–5 m depths on the boulder slope of the study site on the northern slope of West Island (see Kangas & Shepherd 1984). A quadrat, 0.25 m^2 in area, was placed on the boulders and the area within the perimeter was searched systematically for crabs by removal of all boulders down to the sandy substratum. The sand below the boulders was then sifted by hand to collect any burrowing species.

Animals collected were identified to species and preserved in 70% alcohol. Subsequently the gastric mill was removed in the laboratory and the contents mounted on microscope slides in Karo, a light corn syrup. Only gastric mills subjectively estimated to be more than half full were examined in order to avoid biased estimates due to differential retention time of different prey items in the mill (Williams 1981).

Slides were placed on a grid and the material under each of 25 grid intersections was identified to the lowest taxonomic category possible. This method estimates the percentage composition of food items by volume (Berg 1979). Subsequently plant material was classified as green, brown or red macro-algae, filamentous algae (a polyphyletic group), geniculate corallines, comprising species in the genera *Jania*, *Haliptilon* and *Cheilosporum*, seagrass, comprising *Posidonia* or *Heterozostera*, and unidentifiable matter. Animal material was classified as sponge, foraminiferans, echinoderms, molluscs, crustaceans, and unidentifiable matter. The presence of sand grains was also recorded.

A series of "no choice" feeding experiments was conducted in plastic cages set on the sea-bed at West Island to determine whether crabs attacked abalone in the absence of other food, and to determine the nature of shell damage inflicted. In each cage 4–6 juvenile *H. scalaris* over a range of sizes were placed on boulders in the cage with a number (usually 4) of crabs of a given species. Controls with abalone but without crabs, were placed in an adjoining cage and all cages were recovered after intervals of 5–21 days. In addition observations were made on the period of activity of four species of crabs kept in aquaria.

* Department of Fisheries, 135 Pirie Street, Adelaide, S. Aust. 5000.

TABLE 1. *List of crab species at West Island, with their distribution and depth range. B* = boulder slope on northern shore of West Island. E = exposed shores of Island. Depth range in metres.

Family	Species
ANOMURANS	
Porcellanidae	— *Porcellana dispar* (Stimpson) B, 1–5
Lithodidae	— *Lomis hirta* (M. Edwards) B, 1–5
Paguridae	— *Paguristes frontalis* (M. Edwards) B, 3–5
	— *Paguristes sulcatus* (Baker) B, 1–5
	— *Paguristes brevirostrus* (Baker) B, 5.
	— *Pagurus* sp. 1 B, 5.
	— *Pagurus* sp. 2 B, 5.
Galatheidae	— *Galathea australiense* (Stimpson) B, 1–5.
BRACHYURANS	
Majidae	— *Huenia proteus* (de Haan) E, 10.
	Naxia aurita (Latrielle) B, 1–5; E, 13.
	— *Paratymolus latipes* (Baker) B, 2–4.
Goneplacidae	— *Litocheira bispinosa* (Kinahan) B, 3.
Hymenosomatidae	— *Halicarcinus ovatus* (Stimpson) B, 2–4.
Dromidae	*Petalomera lateralis* (Gray) B, 3.
Xanthidae	— *Pilumnus rufopunctatus* (Stimpson) B, 1–5
	— *Pilumnus fissifrons* (Stimpson) B, 1–5.
	Heteropilumnus fimbriatus (M. Edwards) B, 4
	— *Actaea peronii* (M. Edwards) B, 3–4,
	— *Actaea calculosa* (M. Edwards) B, 3.
	— *Megametope carinatus* (Baker) B, 1–5.
Grapsidae	— *Plagusia chabrus* (Linnaeus) B, 1–2.
	— *Brachynotus octodentatus* (M. Edwards) terrestrial
Portunidae	— *Nectocarcinus tuberculosus* (M. Edwards) B, 4–5.

Results

Twenty-three species of crabs, in 11 families, have been recorded in this and earlier collections at West Island (Table 1). Of these 20 were found on the boulder slope in this study. The vertical distribution of density of the six commonest species (density more than $0.1/m^2$) on the boulder slope is shown in Fig. 1. The two species of *Pilumnus* were not readily distinguishable in the field and are plotted together in Fig. 1. *P. fissifrons* was much less common than *P. rufopunctatus*. *Porcellana dispar* escaped rapidly on disturbance and our sampling technique is therefore likely to have underestimated its density.

There are two very abundant species, *Lomis hirta* and the hermit crab *Paguristes sulcatus*, with densities of $10–15/m^2$, and four moderately abundant species *Pilumnus rufopunctatus*, *Paguristes brevirostrus*, *Megametope carinatus* and *Paguristes frontalis*. The remaining species are quite rare with densities of less than $0.1/m^2$.

Five of the six most common species were used for dietary analysis. The mean percentage composition of food in the gut of a sample of 15 of each of these species is given in Table 2. The percentage discarded for gut analysis, where the gastric mill was less than half full is also indicated.

Two species (*Paguristes sulcatus* and *Pilumnus rufopunctatus*) are almost wholly herbivorous, two species (*Lomis hirta* and *Paguristes frontalis*) are mainly herbivorous but take small amounts of animal matter, and one species, *Megametope carinatus* takes about equal amounts of plant and animal matter. Most collections were taken in morning dives, and it seems likely that the high incidence of empty gastric mills recorded by nocturnally active species (Table 2) is related to their nocturnal feeding and rapid fore-gut clearance (Table 3).

The results of "no choice" feeding experiments (Table 3) show that four out of five common species captured and ate small abalone mostly in the length range 15–32 mm. Two species of crab chipped the

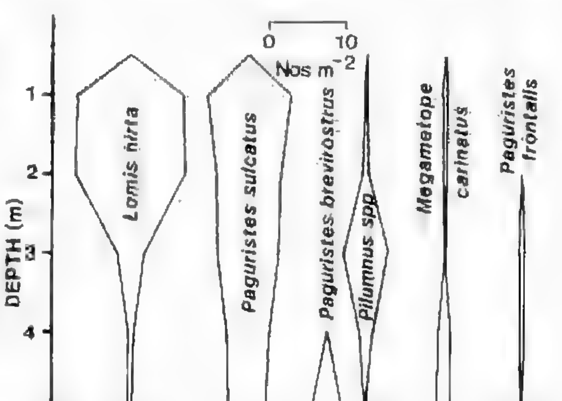

Fig. 1. Distribution of density of crabs on the boulder slope, in Abalone Cove, West Island.

TABLE 2. *Mean percentage composition of contents of gastric mill of five species of crabs. In each case sample size is 15.*

	Lomis hirta	*Paguristes sulcatus*	*Paguristes frontalis*	*Pilumnus rufopunctatus*	*Megametope carinatus*
Macro-algae					
green		2	3	6	—
brown	50	36	7	49	5
red (non-geniculate)	2	6	5	6	10
(geniculate corallines)	6	24	31	3	16
filamentous	9	14	13	16	2
seagrass	1	9	18	7	16
unidentified	5	4	3	1	—
TOTAL % ALGAE	73	95	80	88	49
sponge	—	1	1	—	—
foraminiferan	6	1	1	—	—
echinoderm	1	—	—	—	2
mollusc	5	1	1	5	12
crustacean	1	—	—	—	12
unidentified	7	2	12	1	23
TOTAL % ANIMAL	20	5	15	6	49
sand grains	7	—	5	6	2
% with gastric mill ⊕ half full	35	17	12	52	65

TABLE 3. *The size range of predaceous crabs and prey abalone, and the sizes of abalone, consumed and nature of shell damage inflicted and other details of "no choice" feeding experiments of crabs on abalone. Data on period of activity are from aquarium observations.*

Species	*Lomis hirta*	*Paguristes sulcatus*	*Paguristes frontalis*	*Pilumnus rufopunctatus*	*Megametope carinatus*
carapace width of crab (mm)	11–18	8–12*	13–17*	10–15	18–35
abalone presented (length range – mm)	11–53	6–40	10–49	9–35	15–40
abalone taken (length – mm)	22–27	28, 40	25, 32	—	15–19
damage inflicted	growing edge sometimes chipped	none	growing edge chipped	—	growing edge chipped
number of experiments	2	2	1	1	2
duration (days)	5, 13	5, 13	12	12	13, 21
time of activity	none kept	day time	day time	night time	night time

* inferred from size of shell occupied.

growing edge of the shell (Fig. 2) presumably during the process of capture. The controls showed no mortality of abalone and no chipped shells were observed on any individual.

Discussion

The factors influencing the vertical distribution of crabs are unclear and few comments can be made. *Lomis hirta* is morphologically strongly compressed in the dorso-ventral plane and clings tenaciously to the rock surface. It is thus well adapted to withstand strong water movements that occur in shallow water of 1–2 m depth where it is most abundant. It also has pinnate antennal appendages suggesting that it also can filter feed planktonic organisms. *Megametope* is a burrowing crab mostly found below the sand surface under boulders and this may account for its apparent preference for depths of 4–5 m where sand accumulates between and under boulders.

Fig. 2. Chipped shells of *Haliotis scalaris* eaten by crabs during cage experiments.

Despite the bias toward herbivory in most species, whose feeding was studied, the cage experiments show that all except *Pilumnus rufopunctatus* can capture abalone and that the only damage inflicted by these crab species is slight chipping of the growing edge of the shell. This kind of damage is similar to that inflicted on abalone by crab species of the genera *Gaetice* and *Charybdis* (Kojima 1981), *Loxorhyncus* and *Cancer* (Tegner & Butler 1985) and *Macropipus puber* (Clavier & Richard 1985).

"No choice" experiments do not indicate whether or how many abalone are actually taken by a potential predator. The incidence of dead juvenile abalone shells with chipped edges in the under-boulder habitat is low and only about 1–2/m^2 (Shepherd unpubl.) and this suggests that predation by these crabs is not high. This contrasts with the studies of Kojima (1981) and Tegner & Butler (1985) who reported that from one third to one half of the total mortality of young abalone was attributable to crab predation. Similarly Clavier & Richard (1985) considered crabs a principal predator of *Haliotis tuberculata*.

Acknowledgments

Messrs L. Gray, A. Bennett, V. Karo all gave assistance in the field. We are grateful to Dr P. Abrams for identifying *Paguristes brevirostrus* and to Dr D. J. G. Griffin for identifying earlier collections of crabs from West Island. We thank Mr R. K. Lewis for criticism of the manuscript.

References

Berg, J. (1979) Discussion of methods of investigating the food of fishes, with reference to a preliminary study of the prey of *Gobiusculus flavescens* (Gobiidae). *Mar. Biol.* **50**, 263-273.

Clavier, J. & Richard, O. (1985) "Etudes sur les ormeaux dans la region de Saint-Malo" 285 pp. (Association pour la mise en valeur du littoral de la Côte d'Emeraude, Saint-Malo).

Hines, A. H. & Pearse, J. S. (1982) Abalones, shells and sea-otters: dynamics of prey populations in central California. *Ecology* **63**, 1547-1560.

Kangas, M. & Shepherd, S. A. (1984) Distribution and feeding of chitons in a boulder habitat at West Island, South Australia. *J. Malac. Soc. Aust.* **6**, 101-111.

Kojima, H. (1981) Mortality of young Japanese black abalone *Haliotis discus discus* after transplantation. *Bull. Jap. Soc. Sci. Fish.* **47**, 151-159.

Shepherd, S. A. & Turner, J. A. (1985) Studies on southern Australian abalone (genus *Haliotis*) VI. Habitat preference, abundance and predators of juveniles. *J. exp. Mar. Biol. Ecol.* **93**, 285-298.

Skilleter, G. A. & Anderson, D. T. (1986) Functional morphology of the chelipeds, mouthparts and gastric mill of *Ozius truncatus* (Milne Edwards) (Xanthidae) and *Leptograpsus variegatus* (Fabricius) (Grapsidae) (Brachyura). *Aust. J. Mar. Freshw. Res.* **37**, 67-79.

Tegner, M. J. & Butler, R. A. (1985), The survival and mortality of seeded and native red abalones, *Haliotis rufescens*, on the Palos Verdes Peninsula. *Calif. Fish and Game* **71**, 150-163.

Vermeij, G. J. (1977) Patterns in crab claw size: the geography of crushing. *Syst. Zool.* **26**, 138-152.

Williams, M. J. (1981) Methods for analysis of natural diet in Portunid crabs (Crustacea: Decapoda: Portunidae). *J. Exp. Mar. Biol. Ecol.* **52**, 103-113.

—— (1982) Natural food and feeding in the commercial sand crab *Portunus pelagicus* Linnaeus 1766 (Crusacea: Decapoda: Portunidae) in Moreton Bay, Queensland. *Ibid.* **59**, 165-176.

Zisper, E. & Vermeij, G. J. (1978) Crushing behaviour of tropical and temperate crabs. *Ibid.* **31**, 155-172.